

PRELIMINARY

**TECHNICAL MANUAL
FOR
MODEL 7410
"AC VOLTAGE REFERENCE"**

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1 INTRODUCTION

1.1 SCOPE

This manual contains technical specifications, detailed description, operating instructions, maintenance information, parts lists, and diagrams for the Guildline Instruments 7410 AC VOLTAGE REFERENCE.

1.2 BACKGROUND

1.2.1 DESCRIPTION

The 7410 AC Voltage Reference is a digitally synthesised AC source that uses an erasable programmable read only memory (eprom) to store digitally synthesised waveform data. These digital data are converted to any one of up to 16 waveforms by a digital to analogue converter (dac) configuration that produces an extremely stable AC waveform at low (audio) frequencies. The 7410 allows for the selection of one output voltage waveform out of a preprogrammed maximum of 16. The frequency of the selected waveform can be programmed using either the internal clock of the 7410 to generate any one of up to 16 different frequencies, or an external clock to generate any user selectable frequency. The 7410 is based on the original work performed at the National Institute of Science and Technology (NIST) and described in ¹.

1.3 GENERAL THEORY

Figure 1.1 outlines the general block diagram of the 7410. It can be seen that a 8 kilobyte eprom is used to store digitized waveform information for 16 waveforms. Each waveform in the eprom is described in one byte steps up to a maximum of 512 bytes. In operation the data stored in the eprom for a given waveform is sent alternately to two dacs. One dac is set using bytes on all even addresses of the eprom, while the other is set using all the odd addresses. The output from each dac is time-multiplexed to the output amplifier such that while one dac's output is being changed, the output of the other dac is being used to drive the output. By multiplexing the two dacs in this manner, the step noise generated when the dacs switch, is reduced so that a more stable and accurate voltage (rms) output can be generated.

¹ Oldham, Nile; Hetrick, Paul; Zeng, Xiangren, "A Calculable Transportable Audio Frequency AC Reference Standard", IEEE Transactions on Instrumentation and Measurement Volume 38, Number 2 April 1989, pp.368-371.

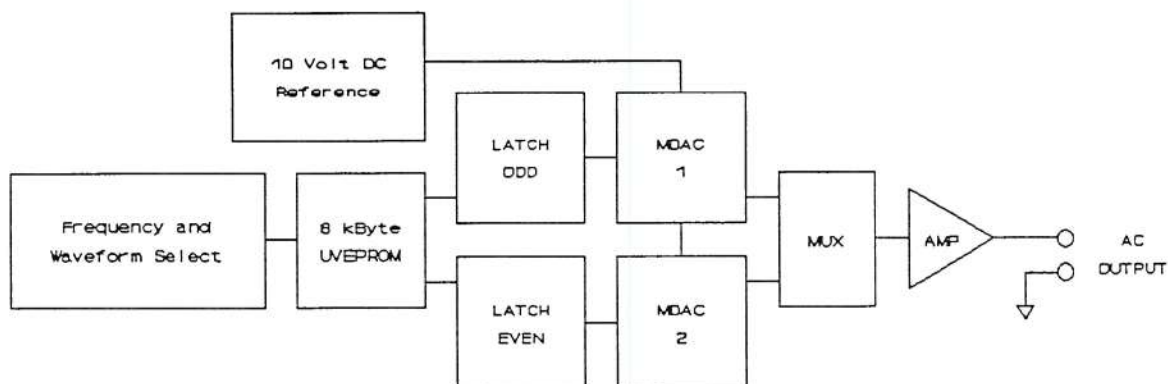


Figure 1.1: 7410 General Block Diagram

This "deglitching" technique enhances the step quality of the output waveform in the audio-frequency range. While this technique reduces the transient energy aberrations at the step transitions, the flatness of the rms value is not well defined (at the parts per million (ppm) level) above about 2 kHz. By trimming the frequency response of the output amplifier to make it band-limited in the audio-frequency range, the rms response can be flattened to within 15 ppm. Normal operation of the 7410 requires the use of a stable +10 V DC reference voltage for the multiplying dac's. This +10 V DC level is internally generated by the 7410. Where a more stable output voltage is required than can be provided by this internal reference, an external reference voltage can be input to the 7410. With a 10 V DC reference, the nominal output of the 7410 is 7.07 Vrms. A 10 MHz source of stable frequency is used by the 7410 in normal operation to provide the instrument's timebase. During the step calibration mode of operation, the internal frequency source is disabled and an external clock source must be used to "step" through the output waveform.

The step calibration mode of operation of the 7410 is required in order to precisely determine the rms value of the generated waveform. In this mode of operation, a calibrated, high accuracy, DC Digital Voltmeter is connected to the output of the 7410 and the amplitude of each step is measured by the voltmeter as one complete period is slowly stepped through. The rms value of the generated waveform is calculated from the square root of the mean value of the square of each of the measured step voltages. The step calibration procedure can be automated when the software provided with the 7410 is executed on an IBM PC or equivalent computer system that contains a National Instruments GPIB controller. The "Conversion Complete" signal from the DVM used in the automated setup, must be available and is connected to the External Clock input of the 7410, to step the dac's through one complete period of the selected waveform. The uncertainty of the calculated voltage at the output of the 7410 is dependant on several factors including

the stability of the +10 V DC reference, the linearity of the dvm and the frequency response of the 7410. Typically, the uncertainty of the 7.07 Vrms output is within ± 15 ppm over the range 0.1 Hz through 15 kHz.

2 SPECIFICATIONS

Power Requirements	20	volt-amps
Voltage Requirements	100,120,220,240	VAC $\pm 10\%$ 50Hz 60Hz
Operating Temperature	+18 to +28	$^{\circ}\text{C}$
Storage Temperature	0 to +50	$^{\circ}\text{C}$
Operating Humidity	< 50%	RH
Dimensions	50.0 X 22.5 X 18.5 Depth X Width X Height 19.7 X 8.9 X 7.3	cm ins
Weight	5.8 12.7	kg lb

Table 2.1: General Specifications

Uncertainty ($\pm$ ppm of output) (Nominal Output 7.07 Vrms, 24 hours, 23°C $\pm$ 5°C)										Number of Steps in Sine Waveform
Frequency Range (Hz)										
0.1	1	10	100	1k	10k	20k	40k	80k	156k	
10	10	10	10	10	20	200				512
10	10	10	10	10	20	50	200			256
10	10	10	10	10	15	20	50	200		128
10	10	10	10	10	20	50	200			64

Table 2.2: Output Uncertainty

NOTE: (1) Output Frequency Range: 0.0093 Hz to 156 250.0 Hz
 (2) Absolute uncertainty, to include traceability to National Standards, is dependant on the absolute uncertainty of the DC Reference and the digital voltmeter used to step-calibrate the 7410.

3 OPERATING INSTRUCTIONS

3.1 INSTALLATION

Place the 7410 on a solid bench. Check that the voltage selector (See Section 3.3.4) on the rear panel of the instrument is set for the correct line voltage. Connect the line cord to an electrical outlet. Make sure that there is no connection to the front or rear terminals of the instrument. Connect the red terminals of REF OUT and REF IN together. Connect the black terminals of REF OUT and REF IN together. Push the POWER button in. The light emitting diode (led) above the POWER button should illuminate. A warm up of 2 to 3 hours should be allowed before use.

3.2 FRONT PANEL CONTROLS

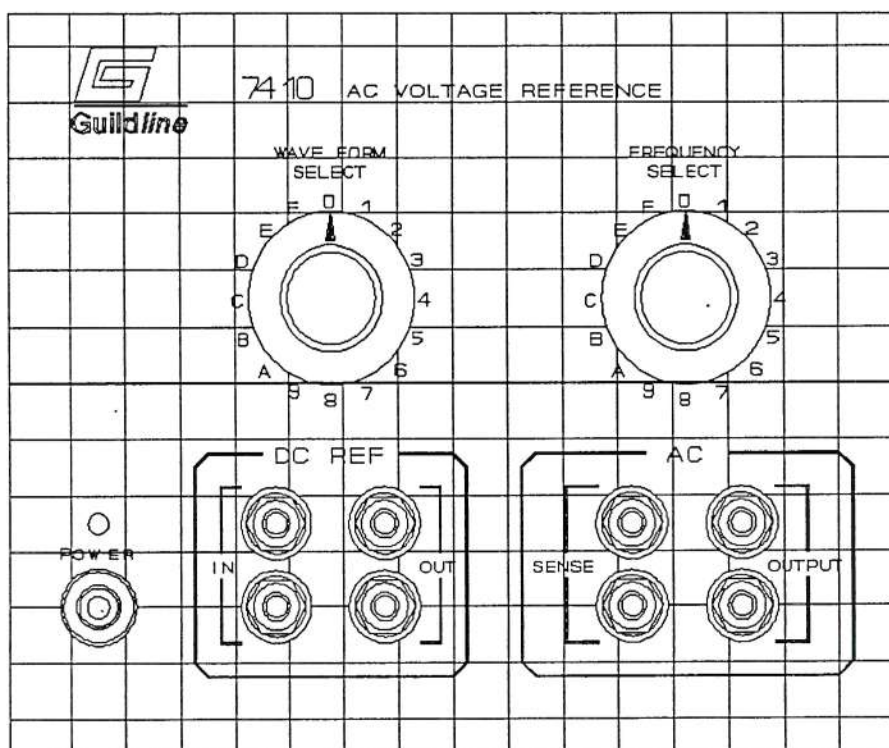


Figure 3.1: Front Panel Controls

3.2.1 POWER ON/OFF

This alternate action push button switch (push on - push off) applies AC line power to the instrument. When this switch is in the ON position the red led above the switch will be illuminated.

3.2.2 WAVEFORM SELECT SWITCH

This 16-position switch is used to select one of the waveforms listed in Table 3.1

DIAL POSITION	WAVEFORM DESCRIPTION	NUMBER of STEPS
0	Ramp	512
1	Sinusoid	64
2	Sinusoid	128
3	Sinusoid	256
4	Sinusoid	512
5	Sinusoid with 40% third harmonic in phase	128
6	Sinusoid with 40% third harmonic shifted 90 °	128
7	Sinusoid with 40% third harmonic shifted 180 °	128
8	Sinusoid with 40% third harmonic shifted 270 °	128
9	Sinusoid with 40% second harmonic in phase	128
A	Sinusoid with 40% second harmonic shifted 90 °	128
B	Sinusoid with pulse and crest factor of 3	512
C	Sinusoid with pulse and crest factor of 5	512
D	Sinusoid with pulse and crest factor of 8	512
E	128 step SCR chopped sine with 90° firing angle	128
F	128 step SCR chopped sine with 45° firing angle	128

Table 3.1: Waveform Switch Selection

3.2.3 FREQUENCY SELECT SWITCH

This 16-position switch is used to select one of the frequencies in Table 3.2

SWITCH POSITION	FREQUENCY
0	1.16 mHz
1	19.53 kHz
2	9.76 kHz
3	4.88 kHz
4	2.44 kHz
5	1.22 kHz
6	610.3 Hz
7	305.2 Hz
8	156.6 Hz 152.6
9	76.3 Hz
A	39.1 Hz
B	19.1 Hz
C	9.5 Hz
D	4.8 Hz
E	2.3 Hz
F	1.2 Hz

Table 3.2.: Frequency Select Switch Position

The frequencies listed in Table 3.2 for the switch positions 0 through F, are for a 512-step waveform only. For 256-step waveforms multiply the frequencies in Table 3.2 by 2. For 128-step waveforms multiply the frequencies in Table 3.2 by 4. For 64-step waveforms multiply the frequencies in Table 3.2 by 8.

3.2.4 DC REF IN TERMINALS

These binding post terminals are on a standard 0.75 inch (.19 mm) pitch, to accept input(s) from a 10 V DC reference. The REF IN terminals allow an external voltage reference to be used in place of the internal 10 V DC source when the links to the DC REF terminals are removed.

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3.2.5 DC REF OUT TERMINALS

These binding post terminals are on a standard 0.75 inch (19 mm) pitch. They terminate the internal 10 V DC reference of the 7410 to the front panel. This output should not be used as a source for any device except the 7410. When this internal reference is used, the associated links to the DC REF IN terminals should be installed (red to red; black to black).

3.2.6 AC SENSE TERMINALS

These binding post terminals are on a standard 0.75 inch (19 mm) pitch. They provide a set of AC sense input terminals that can be driven by the AC load attached to the AC output terminals of the 7410. The 7410 AC SENSE terminals would normally be connected to the output guard of the AC load to reduce errors in the output signal caused by the interconnecting cable between the 7410 and the AC load.

3.2.7 AC OUTPUT TERMINALS

These binding post output terminals are on a standard 0.75 inch (19 mm) pitch, and provide the output voltage connections for the selected waveform. Where 4-wire sensing of the output at the AC load is not used, these output terminals should be linked to the corresponding AC SENSE terminals.

3.3 REAR PANEL CONTROLS

The rear panel controls for the 7410 are shown in Figure 3.2.

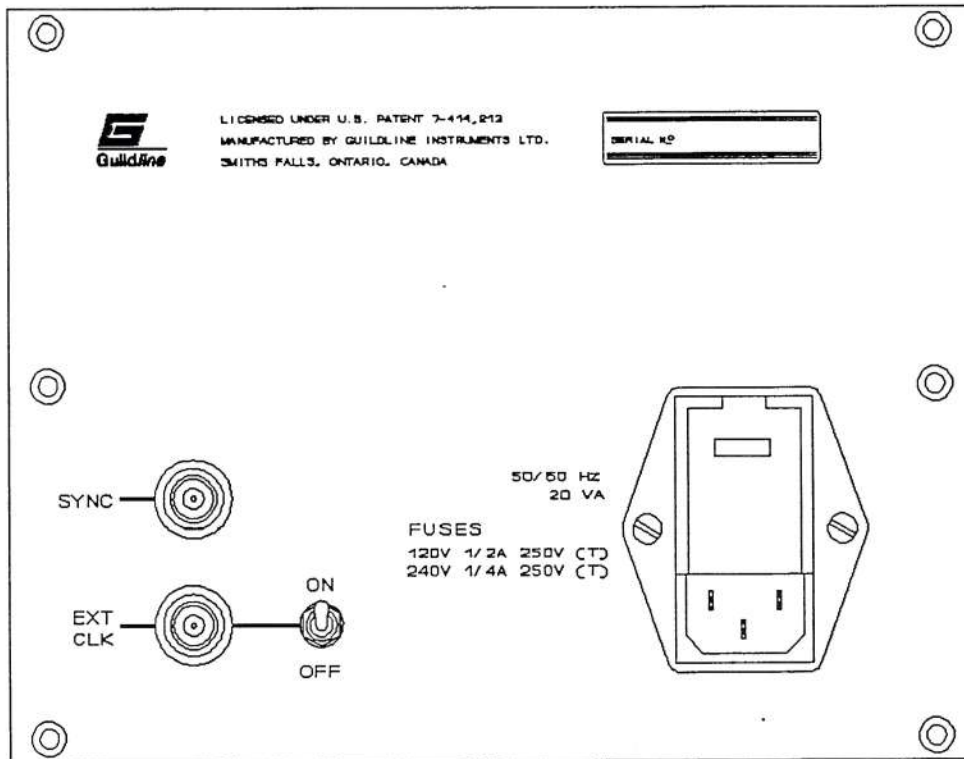


Figure 3.2: Rear Panel Controls

3.3.1 SYNC OUT CONNECTOR

The SYNC OUT output connector is a standard BNC connector. The SYNC OUT signal is a low power output from a 7400 series ttl buffer that can drive up to 16 low power ttl devices. This signal changes state with every 512 steps of the clock (either the internal clock or the externally supplied clock).

3.3.2 EXT CLK CONNECTOR

The EXT CLK input connector is a standard BNC connector. This connector allows for the input of an external frequency signal to control the 7410 clocking. With the EXT CLK switch set to the ON position, the output frequency of the selected waveform will be the frequency at the EXT CLK input connector divided by the number of steps set by the waveform selector switch. The signal source used to generate the external clock should have a 50% duty cycle pulse train with a maximum amplitude between +2.5 V DC and +5.5 V DC and a minimum between ± 0.1 V DC.

3.3.3 EXT CLK ON/OFF SWITCH

The EXT CLK ON/OFF switch is a two position toggle switch that controls the selection of the clock source to be used by the 7410. If the switch is set to the ON position then the 7410 will use the external clock signal at the EXT CLK input, to generate the output frequency. If the switch is set to the OFF position, the 7410 will use its internal crystal controlled clock to generate the output frequency.

3.3.4 POWER RECEPTACLE

The voltage selector drum of the power receptacle allows the 7410 operator to select the line input voltage of the instrument from one of 100, 120, 220, or 240 volts. It is important that the correct line input voltage be selected before any attempt is made to operate the instrument. To change the selected input line voltage, after removing the line cord from the power receptacle, pry open the power receptacle as shown in Figure 3.3.

Check to see that the fuses inserted in the receptacle correspond to the type specified in Table 3.3. Only fuses of the specified type and rating should be used.

Line Voltage	Fuse Type Required
100 volts 120 volts	0.5 A(T) time-lag (MDL- $\frac{1}{2}$, 250 V)
220 volts 240 Volts	0.25 A(T) time-lag (MDL- $\frac{1}{4}$, 250 V)

Table 3.3: Recommended Fuses

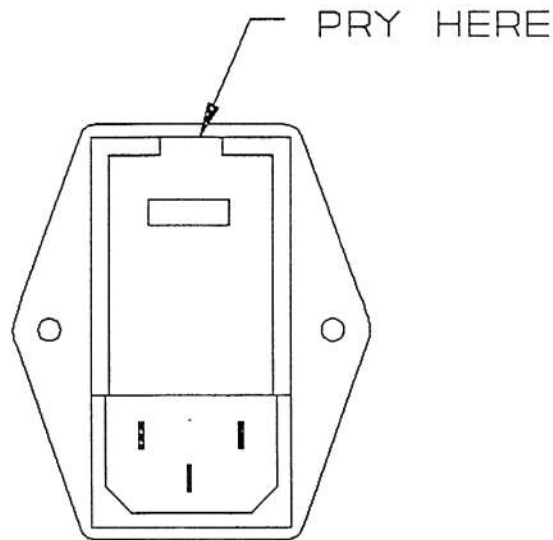


Figure 3.3: Opening the power Receptacle

In order to rotate the drum it must be removed completely from the receptacle. Set the voltage selector drum so that the proper line voltage indication will be visible through the receptacle window when the cover is closed.

Where the supplied line cord does not match the power outlet receptacle, the plug may be removed from the line cord and replaced with a grounded plug of the correct type. The plug should be wired as shown in Table 3.4.

Line Cord Wire Colour	Wiring Details
Brown	Line
Blue	Neutral
Green	Ground (Earth)

Table 3.4: Line Cord Wiring

3.4 OPERATING PROCEDURES

3.4.1 WARM-UP PERIOD

On first powering up the 7410 it should be left ON for a minimum of 2 hours to allow the unit to stabilise.

3.4.2 SELECT REFERENCE VOLTAGE

To use the internal +10 V DC voltage reference, connect the red terminals and then the black terminals of REF OUT and REF IN, respectively, together. If the internal voltage reference is not to be used, then attach an external +10 V DC reference to the REF IN connector, noting the correct polarity (red terminal is positive (+)).

3.4.3 SELECT WAVEFORM AND FREQUENCY

Rotate the WAVEFORM SELECT switch to the desired waveform or number of steps, as described in Table 3.1. Make note of the number of steps in the waveform selected as this will affect the output frequency of the standard (See Paragraph 3.2.8). The output frequency of the generated waveform will be as described in Table 3.2 and set by the FREQUENCY SELECT switch.

3.4.4 SELECT CLOCK SOURCE

To use the preset frequencies provided by the 7410 on its front panel dial, make sure that the clock source select switch (EXT CLK), mounted to the rear panel of the 7410, is in the OFF position. The 7410 will then generate the set of frequencies as described on Table 3.2.

To generate a specific frequency not found Table 3.2, or to generate a more stable frequency output, an external clock can be used with the 7410. The external clock source or frequency generator is connected to the 7410 at the external clock input connector (See Paragraph 3.3.2). After connecting the external frequency generator, set the external clock switch to the ON position. This will cause an output frequency to be generated that is equal to the input clock frequency divided by the number of steps in the selected waveform.

3.4.5 FOUR TERMINAL AC OUTPUT

Connect the AC Sense input terminals to the corresponding AC OUTPUT terminals, AC SENSE red to AC OUTPUT red and AC SENSE black to AC OUTPUT black. This connection can be made at the front panel terminals of the 7410, or at the AC load end of the interconnecting cable. Where an AC guard output signal is available at the AC load, that signal should be used instead and connected to the AC Sense terminals of the 7410.

4 PRINCIPLES OF OPERATION

4.1 INTRODUCTION

The 7410 AC Voltage Reference consists of the following functional blocks:

- a) power supply: to generate DC voltages to power the main pcb assembly.
- b) main pcb assembly: consisting of an output wide-bandwidth power amplifier; an eeprom containing the digital waveform data; two dac's and associated DC voltage reference circuit.
- c) front panel assembly: providing the operator with a set of input/output terminals with two rotary switches to allow selection of the number of steps and the frequency of the output voltage waveform.
- d) rear panel assembly: providing the operator with a set of input/output connectors and selector switch to allow selection of the source for the clock of the 7410.
- e) step calibration software: this software executes on a personal computer to control, through a GPIB interface, an accurate digital voltmeter to perform an automatic step calibration of the 7410.

The functional blocks are described in further detail in the following paragraphs.

4.2 POWER SUPPLY

The power supply assembly used in the 7410 is a model HTAA-16W-A linear power supply manufactured by Condor Inc. This assembly has the following maximum output capacities: +5 V DC at 2.0 A and ± 15 V DC at 0.4 A. The power supply is driven from the line input and can be wired to accept line voltages from one of the following; 100 V AC, 120 V AC, 220 V AC and 230/240 V AC at line frequencies in the range 47 Hz to 63 Hz. Line input voltage selection is made at the fused power input receptacle, as detailed in paragraph 3.3.4.

4.3 MAIN PRINTED CIRCUIT BOARD ASSEMBLY

The main printed circuit board assembly (No. 19071.01.04 schematic) contains all the electronic components of the 7410. A simplified schematic of the 7410 is shown in Figure 4.1.

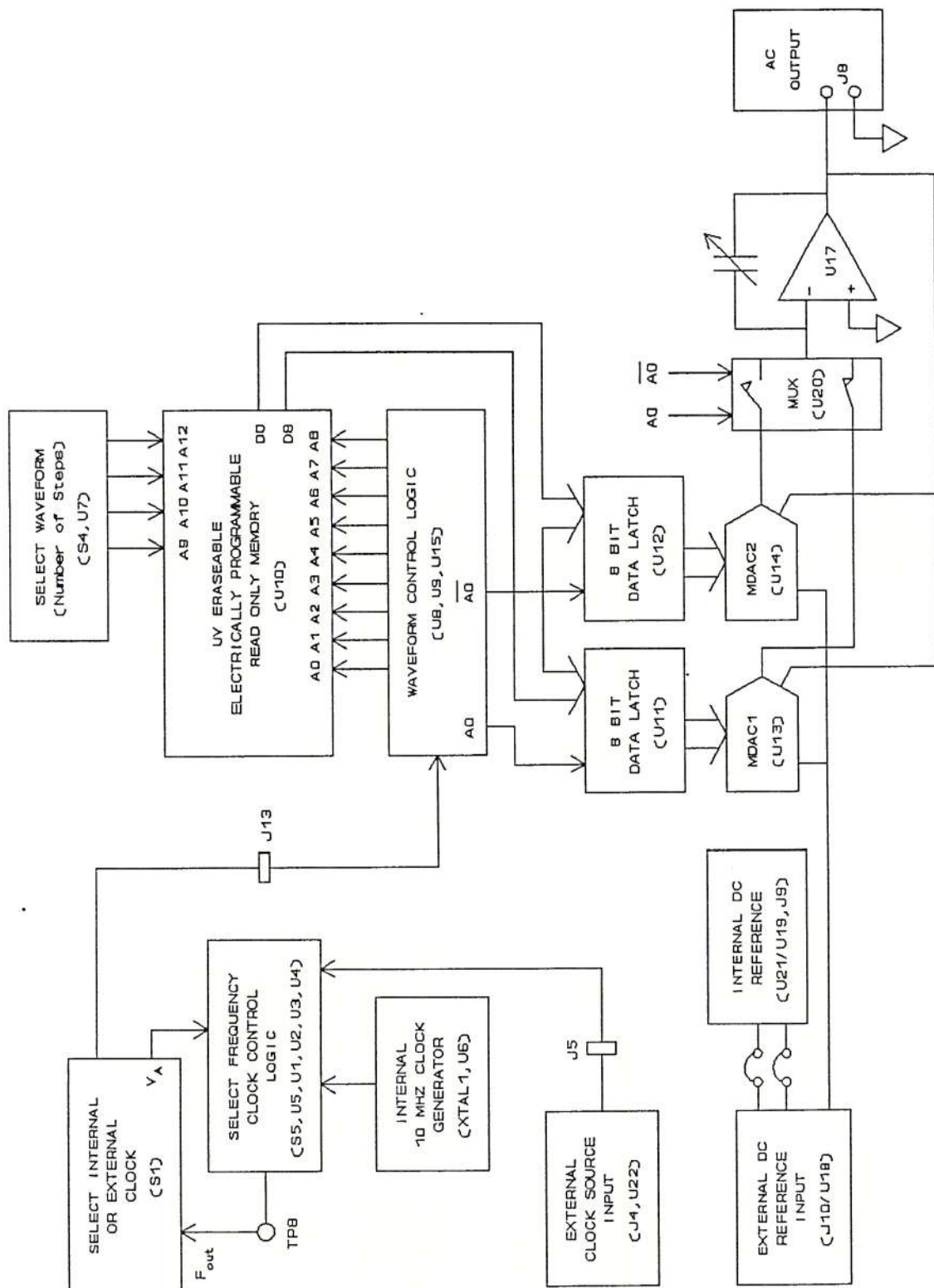


Figure 4.1. 7410 Simplified Schematic

4.3.1 INT/EXT CLOCK

Switch block S1 controls the selection of the clock signal source for the 7410, from either an external frequency generator (at input J4) or the internal 10 MHz crystal controlled oscillator. The selected frequency source output is routed to drive the waveform control logic block at connector J13. When the external clock source is selected by switch S1, the +5 V power supply line (V_A) is disconnected from the integrated circuits at U1, U2, U3, U4, U5, and U6. The external clock connected to J4 is routed through the opto-isolator at U22 (HCPL 2400) to the inverter U16-9 (7404) to drive the clock input lines of the synchronous 8-bit up/down counters of U8 and U9 in the waveform control block. The external clock waveform should have a 50% duty cycle with a minimum amplitude between +2.5 V DC and +5.5 V DC and a minimum between ± 0.1 V DC. The opto-isolator U22 is powered by the power supply and is normally configured such that the opto-isolation capability is defeated.

4.3.2 INTERNAL CLOCK GENERATOR

A 10 MHz crystal oscillator module is installed at XTAL1 to provide the internal clock function or timebase for the 7410 when switch S1 selects the internal clock mod of operation. The time accuracy of this module is no better than $\pm 0.01\%$. Where more stable output frequencies are required, the external clock input should be used and the rear panel switch toggled to select the external clock generator as the main timebase.

4.3.3 CLOCK CONTROL LOGIC

The clock control logic is active when switch S1 is in the internal clock select position. The power supply line (V_A) is connected to the main +5 V DC power supply to apply power to the integrated circuits U1, U2, U3, U4, U5, U6, and switch S5. The frequency select switch S5 is mounted to the front panel and is a rotary, 16-position switch with a hexadecimal coded output and alphanumeric markings (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F). The output from S5 is connected through the one-of-four selector U5 (74LS442) to the data select lines of the one-of-sixteen data selector U1 (74150). The encoded switch (S5) position information on U1 data select lines, select an output frequency at TP8 that is a binary division of the 10 MHz internal crystal oscillator. Any one of 16 frequencies can be selected for output from U1. Integrated circuit's U2, U3, and U4 (74AS867) are 8-bit synchronous up/down counters configured as down counters and cascaded to provide the 16 frequencies at the input lines to U1. The frequencies available at TP8 are listed in Table 4.1.

S5 SWITCH POSITION	FREQUENCY AT TP8 (HZ)
0	0.5950
1	10000000.000
2	5000000.000
3	2500000.000
4	1250000.000
5	625000.000
6	312500.000
7	156250.000
8	78125.000
9	39062.500
A	19531.250
B	9765.625
C	4882.813
D	2441.406
E	1220.703
F	610.352

Table 4.1: Output Frequency Select

4.3.4 Waveform Control Logic

The frequency selected by switch S5 or the external clock is routed through contacts on switch S1 to the input of the waveform control logic of U8 (74AS867), U9 (74AS867) and U15 (74265). The synchronous 8-bit counters U8 and U9 divide the input frequency at J13 by 1024. This divided down frequency is buffered and made available at the SYNC output connector on the rear panel of the 7410. The intermediate binary division ratios (2^1 through 2^9) of the clock frequency connect to the lower nine address lines of the read only memory U10 (27C64).

The free-running clock input to counters U8 and U9 cause the read only memory to cycle through the memory locations X00(hexadecimal) through X1FF(hexadecimal), (where the three bits set by switch S4 determine the value of X). As each address is selected, the 8-bit data programmed in that memory location is presented at the eight data lines D0, D1, D2, D3, D4, D5, D6, and D7 of the read only memory U10. These data are then sequentially latched into the eight data latches of U11 (74LS374) and U12 (74LS374) by the two phase clock generated by U15 (74265) from the least significant address line A0.

Waveform select switch S4, mounted on the front panel, is a 16 position hexadecimal coded switch, annotated with hexadecimal markings. The 4-bit hexadecimal output from switch S4 is routed through the three channel selector U7 (74LS442), to the upper four address input lines of the read only memory U10. The relative position of S4 will thus select any one of 16 memory blocks within U10, where each memory block is 512 bytes in size. The programmed data in the read only memory U10 is organised to output the 16 waveform patterns listed in Table 3.1. Each waveform data pattern takes up to 512 bytes of contiguous memory space in U10.

Latched output data at U11 and U12 drive the inputs to two 10 bit digital to analogue convertors (dac) U13 (DAC10FX) and U14 (DAC10FX). Only the most significant eight bits of each dac are used by the circuit. Both dac's are referenced to the buffered DC voltage input at the DC REF IN input terminals on the front panel. Amplifier U18 (OP27) buffers the input reference voltage in a unity gain configuration. Potentiometer R3 is used to adjust the input offset voltage of U18 to 0 V DC (± 0.5 mV). An external, nominal +10 V DC reference voltage can be connected to the 7410 at the front panel DC REF IN terminals to generate a nominal 7.071 V AC output. The internal 10 V DC reference voltage generated by U21 (REF01) and buffered by U19 (OP27) to the front panel terminals DC REF OUT, can be used as the dac reference, for standalone operation, by interconnecting the corresponding DC REF OUT and DC REF IN front panel terminals.

4.3.5 AC Output

The output from the dac's of U13 and U14 is configured by the resistor networks of (R10, R14, R15, R17, and R11) and (R12, R16, and R8) respectively, with amplifier U17 (MSK738), to operate in offset binary mode. For positive full scale binary input to each dac (all inputs at logic 1 (+5 V DC)) the output from U17 is +10 V DC, and for negative full scale binary input (all inputs at logic 0 (0 V DC)) the output at U17 is -10 V DC. The feedback path for U17 is closed only when the connections between the front panel AC OUTPUT terminals and the AC SENSE terminals are made. The interconnection between the AC SENSE and AC OUTPUT terminals can be made at the front

panel or more appropriately at the AC load.

To fully recover the digital waveform stored in the read only memory, a set of analogue switches U20 (SD5000N) are used in the forward current path of each dac output. The switch pairs associated with each dac are driven from the two phase clock signals generated by U15 such that the dac output is alternately connected to U17 input or to circuit ground. Phasing of the two dac outputs with the analogue switches of U20 is such, that in one phase while one dac output is connected to amplifier U17 to generate the output signal, the other dac is being updated to its new value. On completion of this step, the output from the recently updated dac is then connected to amplifier U17 to generate the output signal, while the other dac is being updated to its new value. Matching of the two dac output paths is made by adjustment of the potentiometers R15 and R26. Full scale positive alignment of the dacs is made at +10 V DC output, by adjusting R15 until the dac outputs are within ± 0.005 V DC for the same binary input (all dac inputs at logic 1). Full scale negative alignment of the dacs is made at -10 V DC output, by adjusting R26 until the dac outputs are within ± 0.005 V DC for the same binary input (all dac inputs at logic 0). The setup procedure to align the dacs (for gain, R15 and offset, R26) calls for the selection of the ramp output waveform and the measurement of two adjacent steps at the start of the ramp (-10 V DC) and at the end of the ramp (+10 V DC).

4.4 SOFTWARE

4.4.1 REQUIREMENTS

4.4.1.1 COMPUTER HARDWARE

The step calibration software provided with the 7410 requires the following minimum computer and related hardware to run:

7410 AC Voltage Reference.
IBM PC or compatible computer.
DOS Version 3.0 or higher.
Colour VGA Monitor.
5¼ (or 3½) Inch Floppy drive.
National Instruments GPIB-PC Controller card.
One of the following DVM's:
 DATRON 1281
 FLUKE 8840
 HP 3456
 HP 3457
 HP 3458

4.4.1.2 STEP CALIBRATION SOFTWARE

The 7410 step calibration software requires the following files to be in the same directory:

7410.EXE
7410.NAM
DA_1281.CFG
FL_8840.CFG
HP_3456.CFG
HP_3457.CFG
HP_3458.CFG

4.4.2 PROGRAM MENU DESCRIPTION

This program is menu driven from a simple command set. To run the program make sure that the hardware configuration is as described above and that the 7410 software provided has been copied to a suitable working directory (floppy or hard disk). Type '7410' at the system prompt and press the 'Enter' key. The opening menu screen will appear with a list of several options. The following paragraphs describe the function of each menu option.

4.4.2.1 D - Describe Program

To select this function the arrow keys on the computer keyboard can be used to position the highlight over the selection required, **D - Describe Program**, and pressing the **Enter** key. This menu option can also be selected by pressing the letter **D** on the keyboard followed by the **Enter** key. This menu option is a simple on screen help function that describes the main functions of the program and provides a detailed guide as to the use of software.

4.4.2.2 K - Calibrate Meter

To select this function the arrow keys on the computer keyboard can be used to position the highlight over the selection required, **K - Calibrate Meter**, and pressing the **Enter** key. This menu option can also be selected by pressing the letter **K** on the keyboard followed by the **Enter** key. This menu option opens a 'parameter window' on the computer screen and allows for the setting of the DVM CORRECTION FACTOR in that parameter window. The DVM CORRECTION FACTOR is calculated by the software and is found by attaching an accurately known DC voltage source to the system DVM and setting the NOMINAL VOLTAGE in the parameter window to the value of the accurately known source. The DVM CORRECTION FACTOR should be calculated for both positive and negative DC input voltages. This menu option is useful only when a quick calibration of the system DVM is required prior to use.

4.4.2.3 M - Modify Parameters

To select this function the arrow keys on the computer keyboard can be used to position the highlight over the selection required, **M - Modify Parameters**, and pressing the **Enter** key. This menu option can also be selected by pressing the letter **M** on the keyboard followed by the **Enter** key. This menu option opens a 'parameter window' on the computer screen and allows for the modification of the variables shown in the parameter window. Variables shown in the parameter window are described in the following paragraphs.

4.4.2.3.1 No. Steps In Waveform

To set this variable, use the arrow keys on the keyboard to position the highlight over the selection **No. Steps In Waveform**. Use the left and right arrow keys to select the number of steps in the waveform. The number of steps in the waveform can be set to one of: 16, 32, 64, 128, 256, or 512.

4.4.2.3.2 Model of DVM

To set this variable, use the arrow keys on the keyboard to position the highlight over the selection **Model of DVM**. Use the left and right arrow keys to select the model. This sub-menu option allows for the selection of one of the DVM's listed in the 7410.NAM file. The DVM's presently supported by the initial release of this step calibration software are: Datron Model 1281, Fluke Model 8840, HP Model 3456, HP Model 3457, and HP Model 3458. This option also selects the ASCII '.CFG' file to be used for the selected DVM.

4.4.2.3.3 GPIB Name of DVM

To set this variable, use the arrow keys on the keyboard to position the highlight over the selection **GPIB Name of DVM**. Text entered into this line should correspond to the naming convention used when setting up the GPIB controller card in the system computer. For the National Instruments GPIB-PC controller card supported by this initial software release, the naming convention is limited to a maximum of seven characters. Since several instruments can be attached to the GPIB cable at the same time as the system DVM, the GPIB name must be unique and must correspond to the name assigned to the GPIB address set when configuring the GPIB controller in the computer. Appendix A details the symbolic naming convention and setup used for the National Instruments GPIB-PC controller card.

4.4.2.3.4 Measurement Precision

To set this variable, use the arrow keys on the keyboard to position the highlight over the selection **Measurement Precision**. Use the left and right arrow keys to select the level of measurement precision. The range of values that can be set for this variable is limited to high, medium, and low. This variable selects the corresponding effective resolution of the system DVM.

4.4.2.3.5 DVM Correction

To set this variable, use the arrow keys on the keyboard to position the highlight over the selection **DVM Correction**. This menu option can be used to enter the DVM CORRECTION FACTOR for both positive and negative inputs of the system DVM. If the two correction factor values are not known, they can be set using **Calibrate Meter** menu selection.

4.4.2.3.6 Number of Loops

To set this variable, use the arrow keys on the keyboard to position the highlight over the selection **Number of Loops** and enter a number from the keyboard. The number entered is the number of times a complete period of the waveform is to be repeated before stopping and displaying the calculated rms value.

4.4.2.3.7 Voltage Range

To set this variable, use the arrow keys on the keyboard to position the highlight over the selection **Voltage Range** and enter a number from the keyboard. The number entered represents the voltage range to which the DVM should be set.

4.4.2.3.8 Nominal Voltage

To set this variable, use the arrow keys on the keyboard to position the highlight over the selection **Nominal Voltage** and enter a number from the keyboard. The number to be entered is the absolute value of the accurately known DC voltage used when calibrating the system DVM using the **Calibrate Meter** menu option. This parameter is used to determine the plus and minus DC offset of the system DVM. It is also assumed by the system software that the value entered is also the absolute value of the +10 V DC REFERENCE VOLTAGE used at the DC REFERENCE input to the 7410. The value entered is used by the step calibration software to calculate a nominal rms value to be used as a comparison with the calculated rms value generated by the menu function **Calibrate 7410**.

4.4.2.4. V - Save Parameters

To select this function the arrow keys on the computer keyboard can be used to position the highlight over the selection required, **V - Save Parameters**, and pressing the **Enter** key. This menu option can also be selected by pressing the letter **V** on the keyboard followed by the **Enter** key. This menu option saves all the parameters that were altered in the menu option **Modify Parameters** to a file named 7410.CFG. When the step calibration program is executed, the data in the file 7410.CFG is loaded into the program to allow continuation of the last set system configuration without having to reset all parameters from the default setup. If 7410.CFG is not present in the default directory on running the step calibration program, a set of default settings are assumed.

4.4.2.5. C - Calibrate 7140

To select this function the arrow keys on the computer keyboard can be used to position the highlight over the selection required, **C - Calibrate 7410**, and pressing the **Enter** key. This menu option can also be selected by pressing the letter **C** on the keyboard followed by the **Enter** key. This menu option sends the necessary GPIB command sequence from the GPIB-PC controller to the system DVM to measure each step of the selected 7410 waveform for one complete waveform period (or multiple periods as set by the Number of Loops parameter) and then calculate the rms value of the waveform.

4.4.2.6 R - Redisplay Report

To select this function the arrow keys on the computer keyboard can be used to position the highlight over the selection required, **R - Redisplay Report**, and pressing the **Enter** key. This menu option can also be selected by pressing the letter **R** on the keyboard followed by the **Enter** key. This menu option redisplays the information displayed on the screen on selection and completion of the option **Calibrate 7410**.

4.4.2.7 P - Print Report

To select this function the arrow keys on the computer keyboard can be used to position the highlight over the selection required, **P - Print Report**, and pressing the **Enter** key. This menu option can also be selected by pressing the letter **P** on the keyboard followed by the **Enter** key. This menu option outputs the screen information displayed as a result of the **Calibrate 7410** menu selection (or from the menu option **Redisplay Report**) to the system printer connected to the LPT1: printer port.

4.4.2.8 F - Display Frequency

To select this function the arrow keys on the computer keyboard can be used to position the highlight over the selection required, **F - Display Frequency**, and pressing the **Enter** key. This menu option can also be selected by pressing the letter **F** on the keyboard followed by the **Enter** key. This menu option displays a table describing all the waveforms available from the 7410, the corresponding front panel waveform switch dial position, and the number of steps in the waveform. By selecting a waveform using the arrow keys, a second table is displayed showing a list of all available frequencies for that waveform and the corresponding front panel frequency switch dial position.

4.4.3 DVM List File (7410.NAM)

This ASCII file (7410.NAM) contains the name of the system DVM file to be used with the 7410 and the step calibration software. The DVM List File contains information on the DVM's supported by the 7410 step calibration software. The file contains the symbolic name of the DVM followed by the name of the associated '.CFG' file. When the step calibration program is executed, the list file is read and the list of DVM's that can be selected is loaded into the menu option **Model of DVM**. The 7410.NAM file also loads the names of the configuration files into memory. The format of the file is as follows:

```
<NAME OF DVM><CR>
<FILENAME>.CFG<CR>
```

```

.
.
.
<NAME OF DVM><CR>
<FILENAME>.CFG<CR>
```

NOTE: The carriage returns <CR> must immediately follow the end of each ASCII string.

4.5 DVM CONFIGURATION FILES

The DVM configuration files used by the step calibration software have the file extension '.CFG'. Each configuration file contains the information required to control the system DVM over the GPIB interface.

The format of the configuration file is detailed in Table 4.2.

For Table 4.1 note the following:

- (a) ' ' represent blanks.
- (b) : - <DC voltage> range followed by the GPIB command in ASCII text.
- (c) : <AC voltage> range followed by the GPIB command in ASCII text.
- (d) : a voltage range of zero is auto range.
- (e) : a line with just a carriage return means end of list of ranges.
- (f) : <CR> represents a carriage return.
- (g) : All lines must immediately terminate with a carriage return after GPIB command.
- (h) : numbers before a GPIB command must have one and only one space after it then followed by a GPIB command.
- (i) : any line with just the carriage return represents an unsupported feature.

Format	Line	Description
<ASCII string><CR>	1	<name of dvm>
<number>_<ASCII string><CR>	2	<highest DC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	3	<DC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	4	<DC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	5	<DC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	6	<DC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	7	<DC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	8	<DC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	9	<lowest DC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	10	<highest AC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	11	<AC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	12	<AC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	13	<AC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	14	<AC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	15	<AC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	16	<AC voltage>_<GPIB Command>
<number>_<ASCII string><CR>	17	<lowest AC voltage>_<GPIB Command>
<ASCII string><CR>	18	<GPIB COMMAND string> External trigger
<ASCII string><CR>	19	<GPIB COMMAND string> Internal trigger
<ASCII string><CR>	20	<GPIB COMMAND string> High precision DC
<ASCII string><CR>	21	<GPIB COMMAND string> Medium precision DC
<ASCII string><CR>	22	<GPIB COMMAND string> Low precision DC
<ASCII string><CR>	23	<GPIB COMMAND string> High precision AC
<ASCII string><CR>	24	<GPIB COMMAND string> Medium precision AC
<ASCII string><CR>	25	<GPIB COMMAND string> Low precision AC
<ASCII string><CR>	26	<GPIB COMMAND string> Number of Readings
<ASCII string><CR>	27	<GPIB COMMAND string> DC filter off
<ASCII string><CR>	28	<GPIB COMMAND string> DC filter on

Table 4.2: DVM Configuration File Format

Format	Line	Description
<number>_<ASCII string><CR>	29	<highest Frequency>_<GPIB COMMAND>
<number>_<ASCII string><CR>	30	<Frequency>_<GPIB COMMAND>
<number>_<ASCII string><CR>	31	<Frequency>_<GPIB COMMAND>
<number>_<ASCII string><CR>	32	<Frequency>_<GPIB COMMAND>
<number>_<ASCII string><CR>	33	<lowest Frequency>_<GPIB COMMAND>
<ASCII string><CR>	34	<GPIB COMMAND string> 6 digit display DC
<ASCII string><CR>	35	<GPIB COMMAND string> 6 digit display AC
<ASCII string><CR>	36	<GPIB COMMAND string> Get reading
<END OF FILE>		

Table 4.2 (Continued): DVM Configuration File Format

4.5.1 DVM GPIB CONFIGURATION FILE EXAMPLE

<BEGINNING OF FILE>

DATRON 1281
1000 DCV 1000
100 DCV 100
10 DCV 10
1 DCV 1
0.1 DCV 0.1
0 DCV AUTO

1000 ACV 1000
100 ACV 100
10 ACV 10
1 ACV 1
0.1 ACV 0.1
0 ACV AUTO

TRG_SRCE EXT
TRG_SRCE INT
DCV RESL7, TFER_ON
DCV RESL6, TFER_ON
DCV RESL5, TFER_OFF
ACV RESL7, TFER_ON
ACV RESL6, TFER_ON
ACV RESL5, TFER_OFF
DCV FILT_OFF
DCV FILT_ON
100 ACV FILT100HZ, ACCP
40 ACV FILT40HZ, ACCP
10 ACV FILT10HZ, DCCP
1 ACV FILT1HZ, DCCP

DCV RESL6
ACV RESL6
RDG?
<END OF FILE>

5 STEP CALIBRATION

Before calibration make sure that the 7410 AC Voltage Reference has had at least 2 to 3 hours to warm up. Connect the system computer, the system DVM, and the 7410 as shown in Figure 5.1.

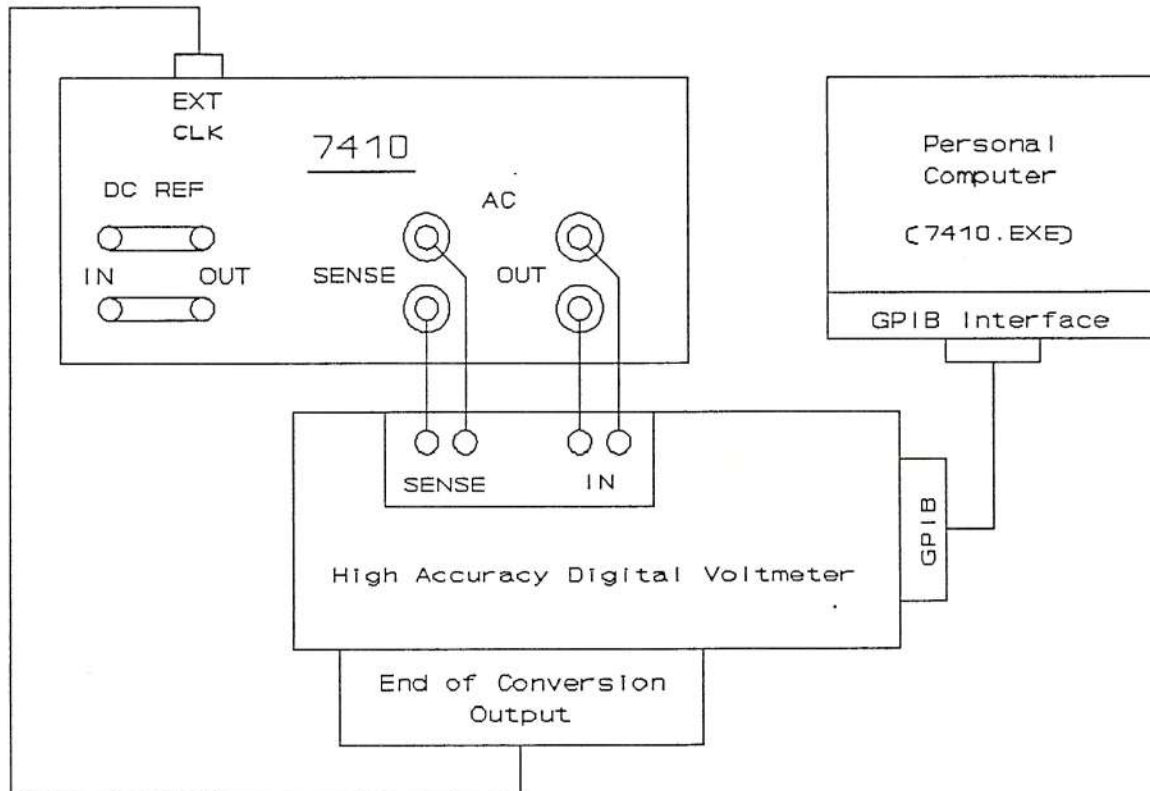


Figure 5.1: Step Calibration of 7410

1. Execute the step calibration (7410.EXE) program.
2. Select the **Modify Parameters** menu option and edit the information in the parameter table according to the current system setup for the DVM being used, the number of steps in the waveform selected etc.
3. Set the EXT CLK switch at the rear of the 7410 to OFF.
4. Select the waveform to be calibrated with the front panel waveform switch.
5. Set the front panel frequency control switch to position 'A' and make an initial AC rms measurement of the 7410 output with the DVM, make sure the AC SENSE and AC OUTPUT terminals are connected.
6. Note the initial rms value reported by the DVM. This value is to be entered later into the entry for Nominal Voltage in the step calibration program.

7. The following instructions are optional:
 - 7a. Connect an accurately known, stable, positive voltage (reference) source to the system DVM.
 - 7b. Select the menu option **Modify Parameter** from the main menu and modify the entry for the **Nominal Voltage** value to equal the value of the voltage reference used in step 7a.
 - 7c. With the value entered, press the <ESC> key on the keyboard to exit the **Modify Parameters** menu. The highlight should now be back in the main menu.
 - 7d. Select the menu option **Calibrate Meter**. This option for the step calibration program will calculate the DVM correction factor for the positive reference voltage.
 - 7e. Repeat 7a. through 7d. using a negative reference voltage.
8. To calibrate the 7410 AC Voltage Reference make sure that the AC SENSE and AC OUTPUT are connected at the front panel or at the system DVM.
9. Check that the conversion complete (measurement finished) signal from the system DVM is connected to the EXT CLK input at the rear of the 7410.
10. Toggle the EXT CLK ON/OFF switch on the rear panel of the 7410 to the ON position.
11. Select the waveform to be calibrated by turning the front panel waveform switch to the desired dial setting.
12. Check Table 3.1 for the number of steps in the waveform and set the **No. of Steps In Waveform** in the parameters window to the correct value.
13. Set the **Nominal Voltage** entry to the value recorded at step 6.
14. Exit the **Modify Parameters** menu.
15. Select the **Calibrate 7410** menu option. This function will step through one cycle of the selected waveform and display the calculated rms value from the measurement of the voltage steps.

NOTE: The uncertainty associated with the step calibration procedure outlined is a function of the gain and linearity errors of the system DVM used to measure each step. To minimise gain errors, the menu function **Calibrate Meter** should be executed immediately prior to performing the step calibration. The short term stability of this calibration is critical and should be better than ± 1 ppm during the test. To minimise linearity errors, the system DVM should have nonlinearities less than ± 2 ppm of full scale.

6 ALIGNMENT

6.1 POWER SUPPLY

Apply line power to the 7410. With a suitable digital voltmeter check that the power supply voltages (+15 V DC, +5 V DC and -15 V DC) are within ± 0.05 V DC of the nominal value. Also at the power supply DC terminals using an oscilloscope check that the noise and ripple on each 15 V DC output is less than 30 mV peak to peak and on the 5 V DC output is less than 150 mV peak to peak.

6.2 DC REFERENCE INPUT

Ensure that there are no connections or links installed between the DC Reference Input and the DC Reference Output terminals or other DC reference source. With the DC Reference Input terminals shorted together at the front panel binding posts, set the voltage at U18 pin 6 to 0.0 V DC ± 0.5 mV DC using potentiometer R3. Remove the shorting link.

6.3 DC REFERENCE OUTPUT

Measure the output at the DC Reference Output terminals on the 7410 front panel. This output should be a nominal +10.0 V DC ± 0.1 V DC. An external DC Reference Voltage can be used in place of the internal 10 V DC source. In this case, any link between the DC REF output terminals and the DC REF input terminals should be removed and the external 10 V DC Reference connected to the DC REF input terminals.

6.4 DIGITAL TO ANALOGUE CONVERTER SETUP

Matching of the two dac's must be accomplished to better than 1 part in 1 000 at both plus and minus full scale output. A digital or other storage oscilloscope can be used to make the two adjustments. This alignment procedure is made by selecting the 512 step RAMP Waveform output and measuring at the AC Output terminals two adjacent step voltages at +10 V DC (near positive full scale or steps 511/512) and -10 V DC (near negative full scale or steps 01/02). Potentiometer R15 is adjusted to bring the two dac outputs at step 511 (or step 512) to within ± 0.005 V of the nominal +10 V DC full scale output. Potentiometer R26 is adjusted to bring the two dac outputs at step 01 (or step 02) to within ± 0.005 V of the nominal -10 V DC full scale output. The frequency of operation during this alignment process is arbitrary and is dependent on the oscilloscope and test equipment used.

Where a GPIB controlled digital voltmeter (dvm) is available, this alignment procedure can be simplified by connecting the output of the 7410 to the dvm, selecting the RAMP waveform, selecting EXT CLK and connecting the "conversion complete" signal from the dvm to the EXT input of the 7410. The test setup is similar to that shown in Figure 5.1 Step Calibration of 7410. A test program running on the personal computer can be used to step the dvm/7410 through the 512 steps of the ramp waveform and read and display the 7410 voltage output at steps 01/02 and steps 511/512. Adjustment of potentiometers R15 and R26 can then be made without the oscilloscope as the test program can be made to loop continuously until the alignment is complete.

6.5 FREQUENCY RESPONSE

With the waveform switch set to position E and the frequency switch set to position 9 a sinusoidal output will be generated by the 7410 of frequency 1.22 kHz. Using an accurate AC voltmeter measure the rms value at the AC output terminals of the 7410. Rotate the frequency switch to position E. A sinusoidal waveform of frequency 39.04 kHz will be output by the 7410. Adjust capacitor C11 until the rms value measured by the AC voltmeter is within ± 20 ppm of the previously measured 1.22 kHz reading.

7 TROUBLESHOOTING AND MAINTENANCE

7.1 TROUBLESHOOTING

Symptom: No output signal.

Possible cause:

- Instrument not plugged in to line power: check line cord.
- Power switch is in the OFF position: check power ON indicator; press power ON switch
- Line fuse blown; check for cause of blown fuse, replace fuse with one of correct rating
- EXT CLK switch in ON position; for free running operation, toggle switch to OFF position
- No DC reference input voltage; connect +10 V DC reference to the 7410 or use internal reference connection at DC out
- No AC sense termination to AC out; connect AC out to AC sense
- failed power supply module; replace power supply
- failed amplifier U17, main pcb assy; replace pcb

Symptom: No DC REFERENCE output voltage (+10 V DC).

Possible cause:

- Instrument not plugged in to line power: check line cord.
- Power switch is in the OFF position: check power ON indicator; press power ON switch
- Line fuse blown; check for cause of blown fuse, replace fuse with one of correct rating
- failed power supply module; replace power supply
- failed amplifier U19, U21 main pcb assy; replace pcb

Symptom: Step calibration does not step sequentially.

Possible cause:

- Instrument not connected to the system DVM end of conversion signal; connect DVM end of conversion signal to 7410 rear input and toggle EXT CLK switch to ON position
- DVM end of conversion signal does not have sufficient drive capability; connect pull up (R19 2K7) by closing LK4.

7.2 PREVENTATIVE MAINTENANCE

Preventative maintenance consists primarily of cleaning, and visual inspection of the instrument. Preventative maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the 7410 is subjected will determine the frequency of the preventative maintenance. A convenient time to perform this maintenance is preceding recalibration or alignment of the instrument.

The 7410 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket to prevent efficient heat dissipation. Dirt can also provide an electrical conduction path which may result in poor instrument performance or in severe cases cause instrument failure. The dress skins of this instrument provide protection against dust build up. Operation without the dress skins in place may necessitate more frequent cleaning.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. In particular, avoid chemicals which contain benzene, toluene, xylene, or similar solvents.

Periodically inspect the instrument for general cleanliness. Remove the cover and clean out any accumulated dust with a soft brush; at the same time check for discoloured or damaged wiring. Check all screws and hardware for tightness.

8 PARTS LISTS

Model 7410

PL19077.01.02	7410 General Assembly
PL19071.01.02	Printed Circuit Board Assembly.

REV		ECN NO. REL		BILL NO PL19077.01.02			
APVD R.J.WCL.		DATE 93/03/04		SH T 1 OF 2			
TITLE		DSS GENERAL ASSEMBLY		MODEL NO 7410			
REV		ECN NO. REL		BILL NO PL19077.01.02			
APVD R.J.WCL.		DATE 93/03/04		SH T 1 OF 2			
TITLE		DSS GENERAL ASSEMBLY		MODEL NO 7410			
ITEM NO	CODE	QTY	STOCK NO	DESCRIPTION	CCT REFERENCE	MFR PART NO	MFR
1	B	1	19079.01.02	Power Harness Set			Guildline
2	B	1	19084.01.02	SYNC. & EXT. CLK. Harnset			"
3	B	1	19085.01.02	Freq.& Waveform select			"
4	B	1	19086.01.02	EXT. Switch Harness			"
5	B	1	19087.01.02	DC REF & AC OUT Connector			"
6	S	1	19071.01.02	DSS PCB General Assembly			"
7	S	2	18931.01.10	Handle			
8	S	1	19072.01.10	Chassis			
9	S	1	19073.01.19	Front Panel Assy			
10	S	1	19074.01.19	Back Panel			
11	S	1	19075.01.10	Bottom Skin			
12	S	2	19076.01.10	Side Skin			
13	S	2	19078.01.10	Top & Bottom Rail			
14	S	1	19081.01.10	Top Skin			
15	S	4	010-24068	Binding Post		4068 GRY/RED	
16	S	4	010-24067	"		4067 GRY/BLK	
17	S	1	018-00444	Rubber Feet		RB-44	Spaenaur
18	S	1	018-0295	Folding Case Legs		M3784-7001	Hammond
19	S	1	018-02220	Fixed Case Legs		M797-24	"
20	F	6	150-05200	Clamp		ABMS-A	
21	S	2	230-01001	Knob	S4,S5	RB-67-2-CSK-7-M	Rogan
22	S	1	250-04030	Line Cord		86537000	Panel Comp.
23	S	1	320-02916	Power Supply		HTAA-16W-A	
24	S	1	150-13026	Grommet, Ledmtg		NSC-003	

REV		ECN NO. REL		 BILL OF MATERIALS GUILDLINE INSTRUMENTS LTD.		BILL NO PL19077.01.02	
APVD R.J. McL.		DATE 93/03/04		TITLE DSS GENERAL ASSEMBLY		MODEL NO 7410	SHT 2 OF 2
ITEM NO	CODE	QTY	STOCK NO	DESCRIPTION	CCT REFERENCE	MFR PART NO	MFR
25	F	10	841-01335	Washer #6 Lock		W2316	Spaenaur
26	F	2	841-01339	Washer #8 Lock		W2317	"
27	F	4	839-06548	" #6 Flat		W2020	"
28	F	2	839-06579	" #8 "		96307	Federal
29	F	4	825-38165	Nut 6-32		HN2003	Spaenaur
30	F	2	825-38172	" 8-32		HN2004	"
31	F	1	812-04079	Screw 6-32 x 1/4 ss fh			"
32	F	4	812-0421	" 6-32 x 1/3 ss ph			Atlas Alloys
33	F	4	812-04434	" 8-32 x 5/8 ss ph			"
34	F	10	812-04113	" 6-32 x 5/16 ss ph			"
35	F	2	812-04372	" 8-32 x 3/8 ss ph			"
36	F	6	813-01150	" 6-32 x 1/2			Spaenaur
37	F	2	812-03870	" 4-40 x 1/4 ss ph		HX205	Atlas Alloys

REV		ECN NO. REL		BILL OF MATERIALS		BILL NO PL19071.01.02	
APVD R.J.WZ.		DATE 93/03/04		GUILDLINE INSTRUMENTS LTD.			
				DSS PCB		MODEL NO 7410	
				TITLE		SHT 1 OF 2	
ITEM NO	CODE	QTY	STOCK NO	DESCRIPTION	CCT REFERENCE	MFR PART NO	MFR
1	S	1	19071.01.07 A	IC Linear	D-A Conv.	U13, U14	DAC 10FX
2	S	2	200-10115	IC Digital		U20	SD5000N
3	S	1	200-65000	IC Linear	OPAMP	U18, U19	OP27EP
4	S	2	200-40196	"	10V REF	U21	REFO1EJ
5	S	1	200-66001	"	OPAMP	U17	MSK 738
6	S	1	200-66738	"	Digital	U5, U7	74LS442
7	S	2	200-25860	"		U1	74150
8	S	1	200-25681	"		U2, U3, U4, U8, U9	74AS867
9	S	5	200-27480	IC Crystal, Oscillator		U23	XO-43-B-10MHz
10	S	1	200-43001	IC Opto/isolator		U22	HCPL2400
11	S	1	200-70115	IC, EPROM MOD		U10	Guilcline
12	S	1	19411.01.12	"		U15	74265
13	S	1	200-25750	"		U16, U6	74LS04
14	S	2	200-25400	"		U11, U12	74LS374
15	S	2	200-25850	Potentiometer 100 Ohm		R15	205-208-100
16	S	1	300-03030	"	10K	R3, R26	205-208-10K
17	S	2	300-03090	Socket 28 pin		U10	D1LB28P-14
18	S	1	410-01028	- 16 pin		S4, S5	D1LB16P-14
19	S	2	410-11016	Capacitor	0.01 uf	C12, 13	CK05BX103K
20	F	2	049-10084	"	.47 uf	C1-6, C14-24, C26, C6A	CK06BX474K
21	F	19	049-10094	"	33 pf	C27	DD330
22	F	1	049-00330	"	0.1 uf	C7, C8	CK05BX104K
23	F	2	049-10092	"	10uf 35V	C30, C31, C9, C10	ITT
24	S	4	041-01269				

REV A		ECN NO. REL		BILL OF MATERIALS GUILDLINE INSTRUMENTS LTD.		BILL NO PL19071.01.02	
APVD R.S. MCL.		DATE 93/03/04		TITLE DSS PCB		MODEL NO 7410 SHT 2 OF 2	
ITEM NO	CODE	QTY	STOCK NO	DESCRIPTION	CCT REFERENCE	MFR PART NO	MFR
25	S	1	047-21070	Capacitor, vari.1.5pf,14pf	C11	8093	Johanson
26	S	7	702-20503	Resistor, 5K +/- 0.01%	R8,9,11-13,16,17	S102K 5K	Vishay
27	F	1	760-00198	" 90.9 ohm	R5	RN60D 90R9F	Milspec
28	F	1	760-00135	" 22.1 ohm	R7	RN60D 22R1F	"
29	F	1	760-00305	" 332 ohm	R18,R20	RN60D 3320F	"
30	F	1	760-00490	" 2K7	R19	RN60D 2741F	"
31	F	2	760-00694	" 15K	R21,R24	RN60D 1502F	"
32	F	2	760-00254	" 200 ohm	R22,R23	RN60D 2000F	"
33	F	1	760-00850	" 39.2K	R25	RN60D 3922	"
34	S	1	17597.01.02	" 4950.0+/- 0.1%	R10		Guildline
35	S	1	799-11119	Resistor Network	RN1	4610-101-471	
36	S	1	158-01065	Heatsink	U17	215-AB	Wakefield
37	F	51	604-02137	Terminals		08-56-0110	Molex
38							
39	S	2	152-12084	Molex connector, 8 pin, Male	J2, J3		
40	S	10	152-02027	" " 2 pin "	J4, J6-14	22-01-2027	Molex
41	S	1	152-02037	" " 3 pin "	J5	22-01-2037	"

9 DRAWINGS

19077.01.02	7410 General Assembly
19071.01.02	Printed Circuit Board Assembly
19413.01.12	Step Calibration Software (2 disks)

